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Application of tecoma flower dye on viscose fabric by using various mordants and mordanting techniques

C Saranya and R Rajakumar

Abstract
At present days there is increasing awareness among people towards natural dyes, because they are non-toxic, non-allergic to skin. Natural dyes have better bio-degradability and higher compatibility with the environment. The dyes extracted from vegetable, minerals or insects are used in textiles. A dye powder is extracted from Tecoma, a bright yellow flower which is grown throughout the world and also be easily available. Alum, Copper sulphate and ferrous sulphate are used as a mordant for Tecoma flower dye. Mordanting techniques like pre Mordanting, post mordanting and simultaneously Mordanting can be used to obtain different shades of colors. The present study was undertaken on application of Tecoma dye in viscose fabric by using various mordants and mordanting techniques to get different shades and compare the physical properties of dyed samples.

Keywords: Tecoma flower dye; mordant; mordanting techniques; viscose fabric; dyeing

1. Introduction
Research into new natural dyes sources along with eco-friendly, robust and cost-effective technologies for their processing and application have greatly aided in widening the scope of natural dyes in various traditional and advanced application disciplines. Dyes made from natural sources such as plants, animals, and minerals tend to produce colors that wash out easily. With most natural dyes, a mordant can be used to make the color more permanent [9]. With an increasing awareness of environmental pollution and health hazards associated with synthesis, processing and use of synthetic dyes, there is a worldwide interest in natural dyes for textiles [10].

The use of non-allergic nontoxic and ecofriendly natural dyes on textiles has become a matter of significant importance due to the increased environmental awareness in order to avoid some hazardous synthetic dyes. However worldwide the use of natural dyes for the coloration of textiles has mainly been conformed to artisan/ craftsman, small scale/ cottage level dyers and printers as well as to small scale exporters and producers dealing with high valued ecofriendly textile production and sales [10]. The manufacturing of synthetic dyes and their extensive utilization commercially for the coloration of various textiles has been disparaged due to introduction of contamination into the environment. Natural dyes, which were also used prior to the advent of synthetic dyes, in textile wet processing for dyeing and printing, may be considered as an environmental-friendly alternative for the preservation of valuable nature. Natural dyes, particularly those derived from various vegetable resources are considered safe owing to their biodegradable and non-carcinogenic characteristics [2].

With the world becoming more conscious towards ecology and environment, there is greater need today to resuscitate the tradition of dyeing with natural dyes as an alternative of the hazardous synthetic dyes. However, the traditional method of dyeing is extremely crude. It is well known that the rural folk dye the yarn by heating chopped leaves or flowers of the plant in water [13]. The application of natural dyes in textile wet processing is a step towards friendly atmosphere process. Today, all over the world, people have come to accept the fact that the natural dyes are more traditional and hygienic [12]. Natural dyes produce very uncommon soothing and soft shades as compared to synthetic dyes [5].

Beautiful flower resources are available throughout the world and they contain wide range of coloring pigments which can be extracted from the flowers and applied on the textiles. Floral dye sources are more significant for dyeing and printing of textile materials as they offer both color pigment as well as fragrance [12, 6].

There are two major classes of flower pigments: carotenoids and flavonoids. Carotenoids include carotene pigments (which produce yellow, orange and red colors) whereas flavonoids include anthocyanin pigments (which produce red, purple, magenta and blue colors). Usually, the color a flower appears depends on the color of the pigments in the flower [8]. Thangarali shows optical absorption around 308 and 205nm. From the results it is concluded that by mixing these dyes at a suitable proportion, it is possible by the dyes to absorb the light in the visible region [4].

Mordants are substances which improve the affinity of a substrate for a particular dye. In case of natural dyes, various metallic mordents are usually employed to improve the fastness properties of the dyed materials as well as to obtain a variety of shades having different tone and hues [2]. Mordant is added to the dye source to influence it, it does not serve as a colour source on it own. The fabric is impregnated with the mordant, during the dyeing process the dye reacts with the mordant, forming a chemical bond and attaching it firmly to the fabric. The choice of mordant depends upon the fabric, an alkali mordant, such as soda ash, works well with cotton, and acid mordant such as vinegar works well with wool [4].

Dyes are applied in an aqueous solution and may require a mordant to improve the fastness of the dye on the fibre, Natural dyes are mostly non-substantive and must be applied on textiles with the help of mordant, usually a metallic salt, having an affinity for both the coloring matter and the fibre. Most of the natural dyes have no substantively on cellulose or other textile fibres without the use of a mordant [14]. To generate an affinity between the fibre and molecules of natural dyes they need the mordanting chemical. Thus, for proper fixation of natural dyes on any textile fibre, mordanting is essential in most of the cases [7]. Most of the natural dyes need chemical species called mordants for binding the dye to fabrics to improve color fastness. Mordants help in binding of dyes to fabric by forming a chemical bridge from dye to fiber thus improving the staining ability of a dye with increasing its fastness properties, The color fastness and characteristics of natural dyes on fabrics are influenced by the mordanting method applied whose effects vary with the source of the dye [11].

Mordants are the substance which is used to fix a dye to the fibres. Mordants also improve the take-up the quality of the fabric and help to improve color and light fastness. Natural dyes require an element to create a bonding between the fabric and the dye particle. The mordant is known as the element which aids the chemical reaction that takes place between the dye and the fibre so that the dye is absorbed. It is a chemical treatment of fabric with metallic salts or other complex forming agents due to which the natural mordantable dyes are bound onto the textile fibre. Mordanting can be achieved by either pre-mordanting, simultaneously mordanting and post-mordanting [15].

2. Experimental

2.1 Selection of Fabric

Table 1: Particulars of the Fabric used for Natural Dyeing

S. No	Fabric Details	
1.	Fabric	Viscose
2.	Composition	100% viscose
3.	Count	30s
4.	Ends per inch warp	80.2
5.	Picks per inch weft	68.8
6.	Width of the fabric	52”
7.	Length of the fabric	9 meters
8.	Cost per meter	Rs. 55.00

2.2 Desizing

In desizing process sizing compounds are removed from gray cloth to make it suitable for dyeing and further processing. The total weight of the given samples was taken and of dilute hydrochloric acid was added to the prescribed amount of water and the sample was immersed in the solution. The temperature was maintained at about 50-60˚c and the time duration was 30 minutes. The material was taken after 30 minutes and given a through rinsing until the water clear. Then the sample was dried thoroughly under the sun light.

2.3 Scouring

Scouring is simply washing to remove all impurities which have accumulated on the fabric during processing. The weighted amount of sodium hydroxide and sodium carbonate was taken and it was wetted with little amount of wetting agent and made into a paste, then required amount of water was added to the paste. The fabric was saturated in pure water for five minutes and the squeezed. The fabric was immersed in scour bath and the temperature was raised to boiling point and it was kept for 30 minutes. After 30 minutes, the material was taken out and given a through rinsing by cold wash. Then the material was dried sun, followed by neutralization.

2.3 Bleaching

The scoured sample was weighed and the bleaching solution was prepared as follows, the chemicals hydrogen peroxide, sodium silicate, soda ash, wetting agents were mixed in a beaker and required amount of water was added to the boiling point and kept for 30 minutes. Then the sample was taken out and rinsed thoroughly and dried under direct sun.

2.4 Selection of Mordant

2.4.1 Alum

This is the most widely used mordant. Alum is a tannic acid is the most commonly used mordant on viscose for good dye take up.It is usually used with cream of tartar, which helps evenness and brightens slightly.

2.4.2 Copper Sulphate

Copper sulphate is also known as blue vitriol. It will also darken the dye colors, similar to using tin, but is less harsh. Copper is rarely used as a mineral mordant. It is used somtines as an ordinary mordant for dyeing.

2.4.3 Ferrous Sulphate

Ferrous Sulphate - Ferrous sulfate (iron) is used as a color changer, darkening or “saddening” natural dyes on protein or cellulose fibers and also increases light fastness for dyes that are prone to fading. Ferrous Sulphate may also be used as the reducing agent in a traditional indigo fermentation vat, often called the “Copperas” vat. Copperas is an older term for iron or ferrous, and this vat is best suited to cellulose fibers.

2.5 Description of Tecoma

Yellow elder grows as a densely branched shrub or small elderberry (*Sambucus Canadensis*). It has bright green opposite leaves, which are innately compound with 1-9 (usually 3-7) sharply pointed oval leaflets. It has bright yellow flowers and dense, lushly green foliage that is evergreen in tropical climates, but deciduous in chillier places.

2.6 Preparation of Tecoma Dye Powder

The fresh flowers were washed, air-dried under shade at room temperature and then milled into powder to obtain a 40–60 mesh materials. The dried powder (120 g) was extracted by soaking with 150 ml of 80% aqueous methanol. After filtration the residue was processed similarly with the same amount of solvent. The methanol extract was concentrated to dryness under reduced pressure at 45°C with a rotary evaporator, lyophilized and were stored at 4°C until further use. Five grams from the methanol extract was further fractionated by successive solvent extraction with ethyl acetate (EtOAc fraction), Chloroform (CHCl3 fraction) and then with *n*-butanol saturated with water (*n*-BuOH fraction).
After organic solvent extraction the remaining aqueous fraction was also used for activity testing (Aq fraction) (Houghton *et al*., 1998). To precipitated alkaloids from the CHCl3 fraction, samples of about 1 g from the lyophilized methanol extract were dissolved in 50 ml of 99% methanol and treated with an equal volume of 1% aqueous HCL then the alkaloids were precipitated by drop-wise addition of 10% NH4OH (Harbored, 1973; Cannel, 1998). The precipitate was collected by centrifugation (5000 rpm at 4°C for 30 min) and washed with 1% NH4OH. The residue was dissolved in a few drops of CHCl3 to obtain the CHCl3 fraction that was containing the precipitated alkaloids. The solvents were removed under reduced pressure and the extracts were concentrated under vacuum at 40-60°C and the weight of the dried mass was recorded.

2.7 Preparation of Tecoma dye solutions

Table 2: Recipe for preparing dye solution for various mordants and mordanting technique

<table>
<tr><th>S. No</th><th>Mordant Name</th><th>Mordanting Techniques</th><th>Recipe</th></tr>
<tr><td>1</td><td>Copper Sulphate</td><td>Pre Mordanting</td><td rowspan="3">Material–1 meter
Coppersulphate-30gms
Dye powder– 15%
Warm water-20 tsp (for making liquid)
Soda ash – 100 ml
Sodium chloride– 2tsp
MLR: 1:15
Temperature- 90°C
Hours – 30mins</td></tr>
<tr><td>2</td><td>Ferrous Sulphate</td><td>Post Mordanting</td></tr>
<tr><td>3</td><td>Alum</td><td>Simultaneous Mordanting</td></tr>
</table>

2.8 Process of dyeing

The above recipes are used for dyeing viscose fabric with different mordant and mordenting techniques. For pre-mordanting technique, A separate samples of Scoured viscose fabric were treated with the mordant solutions of Copper sulphate, Ferrous sulphate and Alum prior to dyeing. This is called as Pre mordanting. For post mordanting technique, the fabric is first dyed with the tecoma flower dye and then the samples are separately treated with the mordanting solution to create different shades. In simultaneously mordanting technique both the mordents and dye powder are mixed in a dye bath. The temperature has to be maintained at 90ºC for 30 minutes with material-to-liquor ratio of 1:15. This process is called as simultaneously mordanting technique.

2.9 Nomenclature of samples

Table 3: The following table deals with the Nomenclature of samples.

S. No	Methods	Mordant	Sample Code
1.	Pre Mordanting	Copper sulphate	VC1
2.	Post Mordanting	Copper sulphate	VC2
3.	Simultaneous Mordanting	Copper sulphate	VC3
4.	Pre Mordanting	Ferrous sulphate	VF1
5.	Post Mordanting	Ferrous sulphate	VF2
6.	Simultaneous Mordanting	Ferrous sulphate	VF3
7.	Pre Mordanting	Alum	VA1
8.	Post Mordanting	Alum	VA2
9.	Simultaneous Mordanting	Alum	VA3

V – Viscose fabric, C – Copper sulphate, F – Ferrous sulphate, A – Alum.

3. Results and Discussion
3.1 Fabric Weight

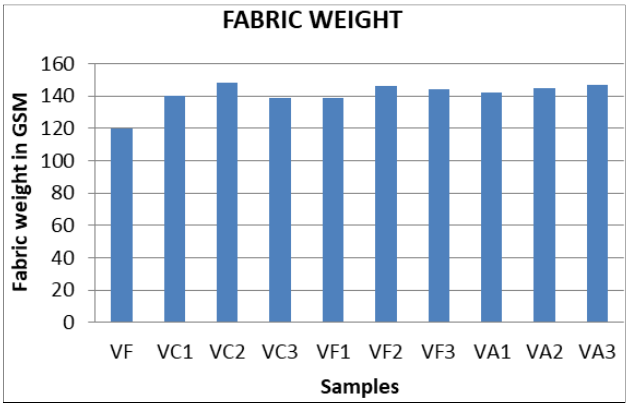


Fig 1: Fabric Weight

Figure 1 reveals that the sample VC2 has maximum fabric weight (148) gsm followed by VA3, VF2.

3.2 Fabric Thickness

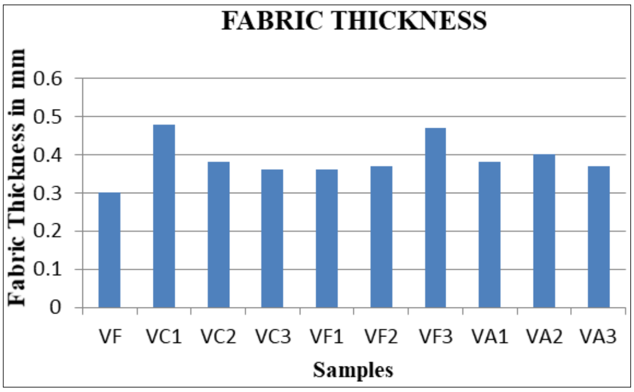


Fig 2: Fabric Thickness

Figure 2 reveals that the sample VC1 has maximum fabric thickness of (0.48) mm followed by VF3 (0.47) mm, VA2 (0.40) mm.

Figure 2 reveals that the sample VC1 has maximum fabric thickness of (0.48) mm followed by VF3 (0.47) mm, VA2 (0.40) mm.

3.3 Tensile Strength
3.3.1 Tensile strength in warp direction

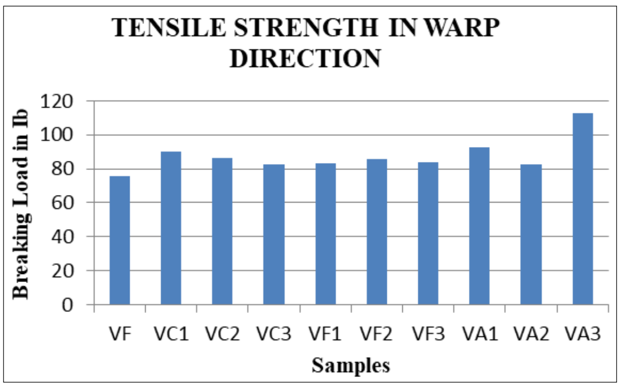


Fig 3: Tensile Strength of the Sample in Warp Direction

Figure 3 reveals that the sample VA3 has maximum fabric tensile strength of (112.8) Ib followed by VC1 (90.2) Ib, VF2 (85.9) Ib

3.3.2 Tensile strength in weft direction

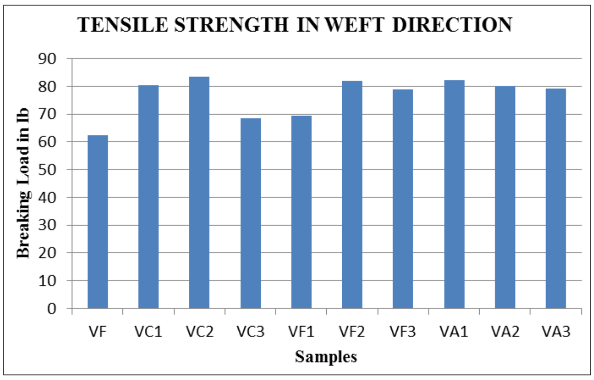


Fig 4: Tensile Strength of the Sample in weft Direction

Figure 4 reveals that the sample VC2 has maximum fabric tensile strength (83.5) Ib followed by VA1 (82.3) Ib, VF2 (82.1) Ib.

3.4 Fabric Stiffness
3.4.1 Fabric stiffness in warp direction

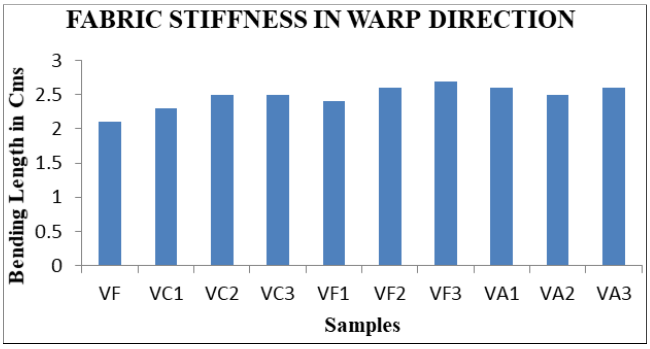


Fig 5: Fabric Stiffness of the Sample in Warp Direction

Figure – 5 reveals that the sample VF3 has maximum fabric stiffness (2.7) cms followed by VA1, VA3 (2.6) cms, VC2 (2.5) cms.

3.4.2 Fabric stiffness in weft direction

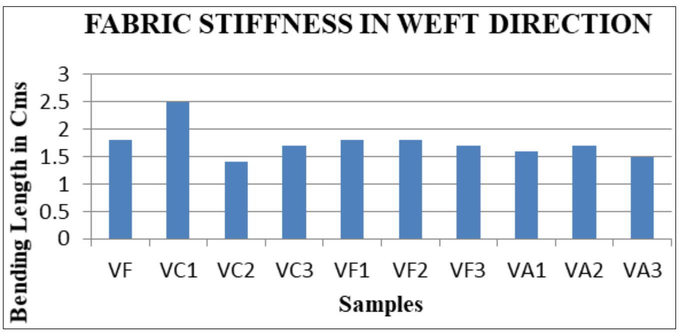


Fig 6: Fabric Stiffness of the Sample in Weft Direction

Figure 6 reveals that the sample VC1 has maximum fabric stiffness (2.5) cms followed by VF1 cms, VF2 (1.8) cms, VA2 (1.7) cms

3.5 Crease Recovery
3.5.1 Crease Recovery in Warp Direction

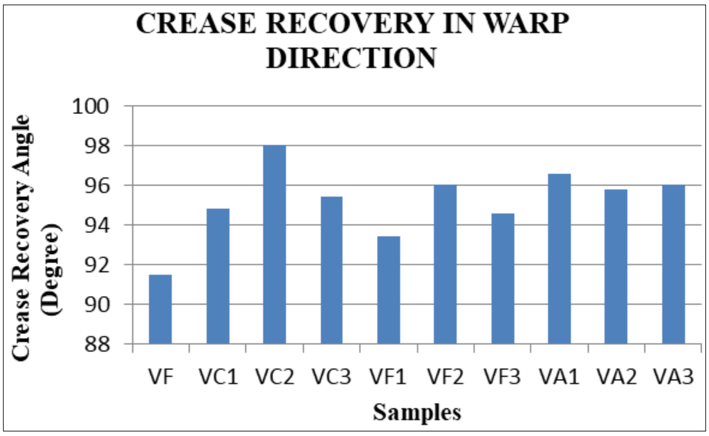


Fig 7: Crease Recovery of the Sample in Warp Direction

Figure 7 reveals that the sample VC2 has maximum fabric crease recovery angle (98°) followed by VA1 angle (96.6°), VF2 angle (96°).

3.5.2 Crease recovery in weft direction

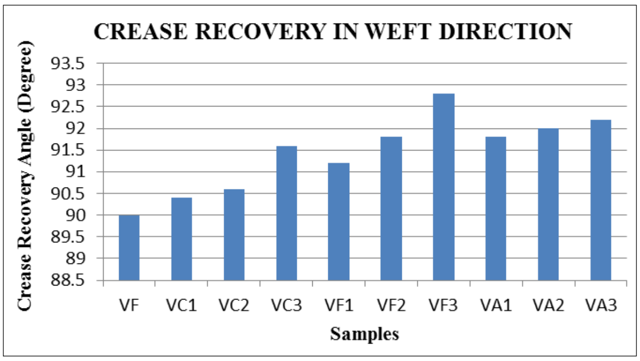


Fig 8: Crease Recovery of the Sample in Weft Direction

Figure 8 reveals that the sample VF3 has maximum fabric crease recovery angle (92.8°) followed by VA3 angle (92.2°), VF3 angle (92.8°).

3.6 Tear Strength
3.6.1 Tear strength in warp direction

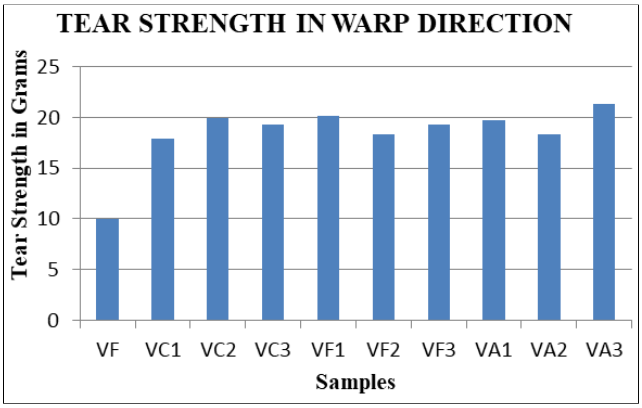


Fig 9: Tear Strength of the Sample in Warp Direction

Figure – 9 reveals that the sample VA3 has maximum fabric tear strength (21.3) grams followed by VF1 (20.2) grams, VC2 (19.9) grams

3.6.2 Tear strength in weft direction

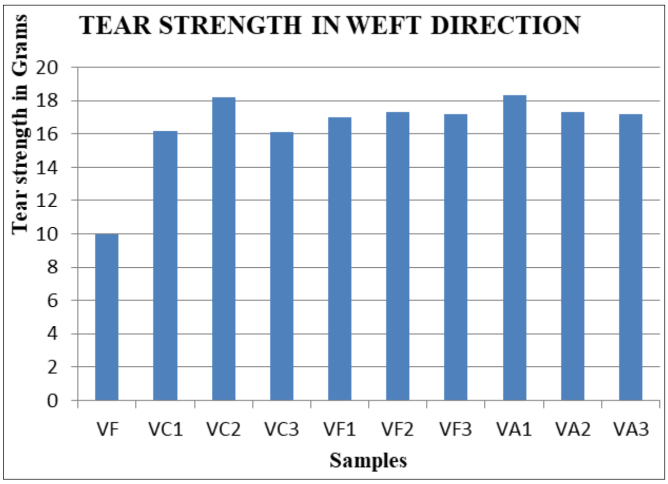


Fig 10: Tear Strength of the Sample in Weft Direction

Figure – 10 reveals that the sample VA1 has maximum fabric tear strength (18.3) grams followed by VC2 (18.2) grams, VF2 (17.3) grams

3.7 Fabric abrasion resistance

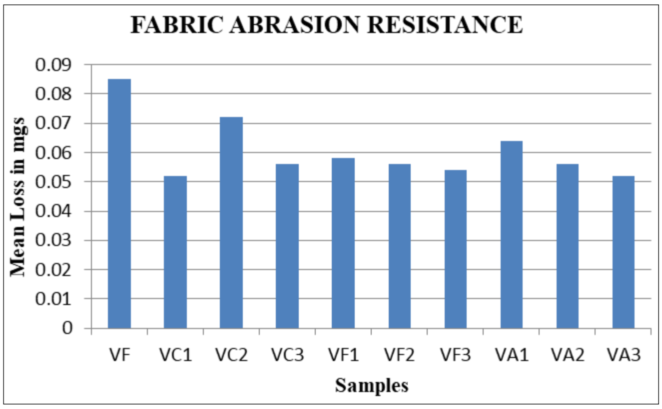


Fig 11: Abrasion Resistance of the samples

Figure – 11 reveals that the sample VC2 has maximum fabric Abrasion resistance (0.072) mgs followed by VA1 (0.064) mgs, VF2 (0.058) mgs.

3.8 Colour Fastness Test

The color fastness to pressing, washing, perspiration and rubbing of the sample are presented in the table 4.

Table 4: Colour Fastness Test

Samples	Pressing		Perspiration		Crocking		Washing	
	Dry	**Wet**	**Acid**	**Alkali**	**Dry**	**wet**	**color change**	**staining on color**
VC1	5	4/5	5	5	5	5	4	4
VC2	5	5	4/5	4/5	5	4/5	4	4
VC3	4	3	3	3	4	4	3/4	3
VF1	5	5	4/5	4	5	4/5	4	4
VF2	5	5	4	3/4	5	4/5	4	5
VF3	4	3/5	3	3	4	3	3/4	3/4
VA1	5	5	4/5	5	5	5	4	4
VA2	5	4	5	3/4	4/5	4/5	4	4
VA3	4	3	3	3	3	3	3	3/4

Note: 5 – Excellent, 4/5 – Very good, 4 – Good, 3/4 – Fair, 3 – Moderate, 2-Poor, 1 – Very poor, Cc –color change, Sc – staining on color.

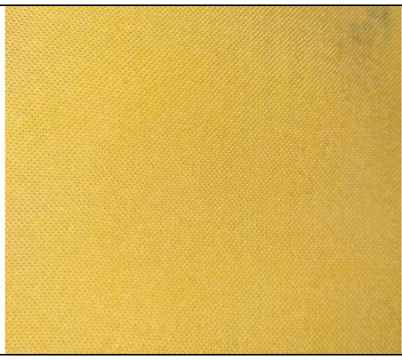
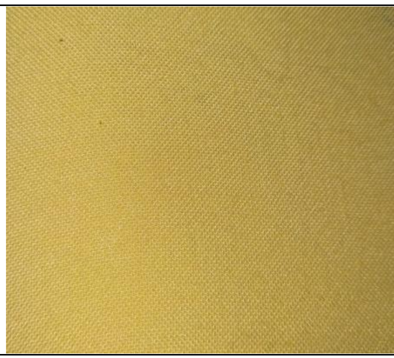
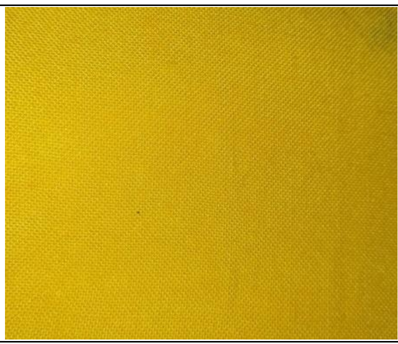
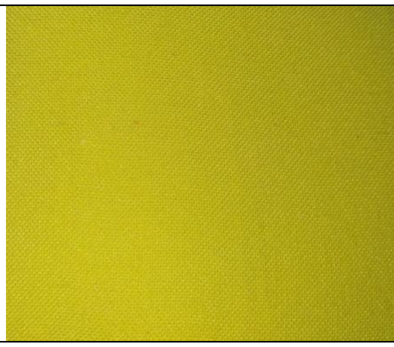
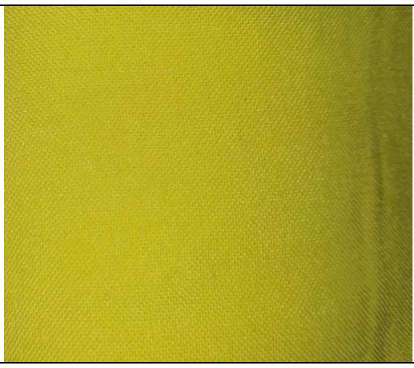
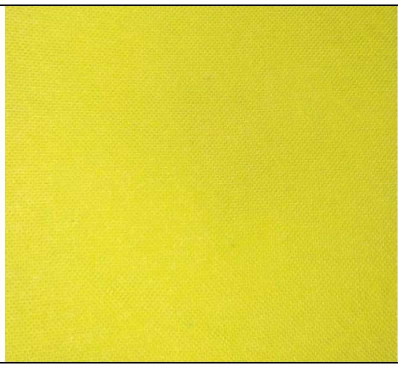
From table – XV shows color fastness test. It is evident that the samples VC1, VC2, VF1, VF2, VA1, and VA2 are rated as excellent in color fastness to pressing.

It is evident that the samples VC1, VC2, VF1, and VA1 samples are rated as excellent in color fastness to both acid and alkaline perspiration.

In the color fastness to rubbing the samples VC1, VC2, VF1, VF2, VA1 are rated as excellent to dry rubbing the samples. VC1, VA1 are rated as excellent for wet rubbing.

Color fastness rating to washing showed that VC1, VC2, VF1, VF2, VA1, and VA2 are rated excellent washing property.

Table 5: Dyed Samples

VC1	VC2	VC3
		
VF1	VF2	VF3
		
VA1	VA2	VA3
		

4. Conclusion

From the study, it can be concluded that the Tecoma flower dye can be used as a dye for coloring textiles and evaluating physical properties of dye samples. It can also be inferred that the extraction of dye from Tecoma flower was easy and economical. It is an eco friendly method of coloring textiles. Different shades of color can be obtained using different mordants. At the same time same mordant can be able to create different shades of color by changing of mordanting techniques like for pre mordanting, post mordanting and simultaneously mordanting. This study clearly evident that, to obtain different shades of the same color we are not supposed to change any mordant or dye powder. We can simply change the mordanting technique to obtain different shades.

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